

**Commonwealth of Virginia  
Department of Fire Programs**



Standard Criteria for Burn Building Prop Construction Documents

to qualify for

**“Grant Awards to Construct, Renovate, or Repair Burn Buildings  
throughout the Commonwealth”**

**Effective January 1, 2007  
Approved at December 14, 2006 VDFP Board Meeting**

**THIS DOCUMENT HAS BEEN PREPARED IN A PERFORMANCE/OUTLINE  
SPECIFICATION FORMAT**

**Notice**

It is important to understand that a performance/“OUTLINE” Specification does not conclusively address construction materials or technique, or similar substantive matters ...if at all. It is intended to cover new construction, renovations, and/or repair work. As such it attempts to focus only on outcome expectations such as durability and longevity, intensity of maintenance and frequency of replacement of sacrificial components; as-well-as inclusive systems and any equipment needs, layout including architectural plan, grounds and any out-structures, and the like.

# STANDARD CRITERIA FOR BURN BUILDING PROP CONSTRUCTION DOCUMENTS

## 1. GENERAL DESIGN REQUIREMENTS

*The following criteria are intended for the **Design, Construction, Renovation, and Repair** of a burn building prop. The criteria below are not for use in specific fire fighter training guidelines.*

### A. BURN BUILDING PROP DESIGN CRITERIA

1. Construction documents for the burn building prop shall be based on the current edition of the Virginia Uniform Statewide Building Code (VUSBC).
2. The burn building prop shall, at a minimum, provide facilities that will support live fire training opportunities in Firefighter I and II as well as Driver Operator programs for pumpers and aerials.
3. The burn building prop super structure must have a minimum design life span of 20 years under the intended specified use.
4. Renovations or repairs to existing burn building props shall be based on a cost effective measure relative to the original life span expectancy of the burn building prop.
5. The burn building prop shall meet current NFPA, OSHA, federal, state, and local codes, and standards at time of design submittal to the board.
6. The burn building prop must be suitable for live fire, Class "A", and/or Class "B" fuel burns.
7. Construction documents for the burn building prop must be signed and sealed by a Virginia Registered Design Professional.
8. A code modification request must be submitted by the Registered Design Professional when the construction documents are submitted for building permit review, denoting the use of the structure as a burn building prop.
9. Construction documents for the burn building prop shall be approved by the Virginia Department of Fire Programs based on the following minimum criteria:

### B. LIVE FIRE TRAINING BURN BUILDING PROP DESIGN CRITERIA

1. Minimum number of live fire training days per year: 120
2. Minimum number of live fire training evolutions per day: 10
3. Minimum duration of each live fire training evolution: 20 minutes
4. Minimum sustained temperature in burn room(s) during live fire training: 1,500° F
5. Minimum temperature spike in burn room(s) during live fire training: 1,800° F
6. Live fire training shall be in accordance with NFPA 1403 and the written guidelines of the Virginia Department of Fire Programs.
7. No training that includes tear gas, explosives, or firearms shall occur within or near the burn building prop.

### C. DESIGN LIVE LOADS

1. Floors: 100 psf
2. Stairs: 100 psf

3. Flat and sloped roofs: 100 psf
4. Exterior apron slab: 125 psf

#### **D. DESIGN WIND LOADS**

1. The structure shall be designed for wind in accordance with the International Building Code as adopted and amended by the current edition of the VUSBC.
2. Basic wind speed: Varies by site location
3. Wind load importance factor (I): 1.0
4. Wind exposure category: Varies by site location

#### **E. DESIGN EARTHQUAKE LOADS**

1. Seismic design shall be performed in accordance with the International Building Code as adopted and amended by the current edition of the VUSBC.
2. 0.2 second spectral response acceleration  $S_s$ : Varies by site location
3. 1 second spectral response acceleration  $S_1$ : Varies by site location
4. Seismic hazard exposure group: I
5. Seismic performance category: Varies by site location

## **2. ARCHITECTURAL**

#### **A. MINIMUM BURN BUILDING PROP REQUIREMENTS**

1. Minimum height: two (2) stories
2. Minimum first floor area: 1,000 s.f.
3. Minimum second floor area: 600 s.f.
4. Minimum lower roof area: 300 s.f.
5. Minimum upper roof area: 600 s.f.
6. Minimum exterior apron width: 15' width along all elevations
7. Minimum rooms within burn building prop: 8
8. Minimum burn rooms: 2
9. Minimum burn rooms per floor: 1
10. Minimum area per burn room: 144 s.f.

#### **B. MINIMUM PROP ACCESS**

1. Minimum number of exterior stairs: 1
2. Minimum number of interior stairs: 1

### **C. DOOR AND WINDOW OPENINGS**

1. All windows shall have hinged shutters.
2. All exterior openings shall have operable shutters and doors.
3. All window and door openings shall have coated metal frames.
4. Minimum number of windows: 5
5. Minimum number of exterior doors: 3
6. Minimum number of interior doors: 1
7. Minimum number of roof access openings: 2
8. Minimum number of means of egress per room: 2

### **D. FLOORS**

1. All floors must pitch to drain water from the interior of the training prop.
2. First floor and exterior apron shall be cast-in-place concrete slab on grade.
3. Second floor shall be either cast-in-place concrete, structural steel, light gage steel framing, or a combination of both.

### **E. ROOF**

1. Two separate roof systems must be provided to achieve a flat and sloped roof training surface.
2. An access opening must be provided through each roof surface.

### **F. WEATHERTIGHT/MOISTURE RESISTANCE**

1. Prop must limit light penetration and be weathertight.
2. Exterior metal surfaces shall be coated to protect from exterior environmental exposure.
3. Interior metal surfaces shall be coated to protect surface from environmental exposure, expected use, and life span of burn building prop.

### **G. SIGNAGE**

1. The burn building prop shall have mounted written user guidelines on building indicating proper usage according to NFPA, local code, and maximum temperature recommendations.
2. No vehicles other than vehicles involved in the live fire training shall be allowed within 15'-0" of the burn building prop.

### **H. PROTOTYPE**

1. A prototype design for the burn building prop has been prepared for the Virginia Department of Fire Programs which meets or exceeds the minimum standard criteria noted within this document. This prototype is described as Commonwealth of Virginia Burn Building Prototype-1.
2. Burn building prop prototype is not designed for forcible entry training. However, forcible entry components can be added to the burn building prop design provided that operation of the forced entry components does not damage the burn building prop.

### **3. STRUCTURAL**

#### **A. GENERAL**

1. The structural framing (super structure) for the burn building prop will be reinforced cast-in-place concrete framing, pre-cast concrete elements, light gage metal, or structural steel coated to anticipated environment, loading and usage levels.
2. Main supporting column elements of the structural framing system shall be maintained outside of the defined burn rooms or thermally insulated as required with suitable materials.
3. Structural framing elements in burn rooms shall be protected by:
  - a) Vertical Surfaces: Thickened high strength concrete walls with steel plate flame impingement retarder, sacrificial CMU walls, calcium silicate treated insulation system utilizing a steel plate flame impingement retarder or equal concrete-based thermal tile mechanically attached or an equivalent substitution approved by the Virginia Department of Fire Programs.
  - b) Floor Surfaces: Thickened high strength concrete slabs or recessed firebrick.
  - c) Soffit or Ceiling Slabs: Thickened high strength concrete slabs with steel plate flame impingement retarder, calcium silicate treated insulation system utilizing a steel plate flame impingement retarder or equal concrete-based thermal tile mechanically attached or an equivalent substitution approved by the Virginia Department of Fire Programs.
  - d) All structural columns within burn rooms shall be protected by thermal insulation.
4. All above criteria may be exchanged or designed with a recognized industry standard substitution.

#### **B. FOUNDATIONS**

1. Contractor shall notify "Miss Utility of Virginia" prior to beginning excavation for location of underground utilities.
2. All column footings shall be centered under column center lines unless noted otherwise.
3. All utilities which cross footings must pass above footings through the foundation wall, sleeve, patch, and parge. Step footings as required. Reinforcing shall be continuous at all footing steps.
4. Concrete slabs on grade shall bear on a minimum of 6 mil vapor barrier and 4" crushed stone. Where required, soil under footings shall be compacted to at least 95% of maximum density as determined by ASTM Method D-698 (standard proctor).

#### **C. CONCRETE**

1. Concrete for footings shall have a minimum compressive strength of 3,000 psi at 28 days and a maximum water/cement ratio of 0.5.
2. Concrete for floor slabs, walls, and other above ground construction shall have a minimum compressive strength of 3,500 psi at 28 days and a maximum water cement ratio of 0.45 at 28 days unless noted otherwise.
3. Concrete utilized in burn rooms shall have a minimum compressive strength of 4,000 psi at 28 days and a maximum water cement ratio of 0.45 at 28 days unless noted otherwise. No additional mixture other than air-entrained shall be permitted.
4. All concrete shall be mixed, placed, and tested in accordance with the latest edition of ACI 318.
5. All concrete shall have a maximum slump of 4" unless noted otherwise.
6. Concrete mix design shall use only carbonate aggregate. Fly ash, siliceous aggregate, or gravel and blast furnace slag are not permitted.

7. All concrete exposed to the exterior environment or to deicing chemicals and/or exposed to "heat of burn" shall be air-entrained 6% by volume  $\pm$  1%.
8. Reinforcing bars shall be epoxy coated ASTM A-775, Grade 60.
9. Concrete reinforcing steel will be protected by a minimum of 2 1/2" concrete cover. Where protected by a specified lining/tile system and not exposed to direct flame impingement, 1 1/2" of concrete cover shall be allowed understanding all damaged lining is replaced immediately. Immediate tile replacement should be indicated on the mounted prop instructions.
10. Pre-cast concrete elements may be installed in areas of the burn prop not exposed to heat-of-burn with no joints in horizontal applications. Concrete mix design and reinforcement details of pre-cast elements shall be the same as required for cast-in-place concrete.

#### **D. MASONRY**

1. Concrete masonry units shall be in accordance with ASTM C-90. Mortar to conform to ASTM C-270, Type "S" below grade and Type "N" above grade. Masonry grout to conform to ASTM C-476.
2. All reinforcing of CMU walls shall be detailed and constructed per ACI 318.
3. All concrete masonry construction shall be constructed to have a minimum design compressive strength ( $f'_m$ ) of 1,500 psi. All masonry grout shall have a minimum compressive strength of 3,000 psi.

#### **E. STRUCTURAL STEEL**

1. All structural steel framing shall be in accordance with the latest edition of A.I.S.C. "Manual of Steel Construction". All structural steel beam, column and channel shapes shall be ASTM A-992. All steel angles and plates shall be ASTM A-36. All structural steel tubes shall be ASTM A-500 Grade B.
2. All structural steel shop work to be welded with E70xxx electrodes. Field work connections to be bolted with 3/4" high strength A325X bolts or welded with E70xxx electrodes. Pre-drill holes in steel members as required for fastening, blocking, etc.
3. Steel deck materials and construction shall be in accordance with the recommendations of the "Steel Deck Institute Design Manual for Composite Decks, Form Decks, and Roof Decks" and with the "Steel Deck Institute Diaphragm Design Manual".
4. Exposed structural steel shall be coated to protect surface from environmental exposure and life span of burn building prop.

#### **F. COLD FORMED STEEL FRAMING**

1. Cold formed steel members shall conform to the latest edition of AISI specifications for the design of cold formed steel structural members.
2. Cold formed steel framing members shall be hot-dip galvanized cold-formed steel studs, runners and bracing of types and sizes as required. Horizontal bracing of stud walls shall be installed in accordance with the manufacturer's recommendations and at 5'-0" on center maximum spacing.

#### **G. PRE-ENGINEERED METAL BUILDING**

1. Metal building manufacturer shall be a member of the Metal Building Manufacturer's Association (MBMA). Contractor shall submit sealed Virginia licensed professional engineer's structural design calculations and shop drawings for review prior to construction of metal building foundation.
2. Metal building manufacturer shall provide a complete and properly installed system as required for a weather tight, 20 year warranted building.
3. Exposed structural steel shall be coated to protect surface from environmental exposure and life span of burn building prop.

## **4. MECHANICAL/ELECTRICAL**

### **A. GUIDELINES**

1. Temperature monitoring system shall consist of a central recorder located in a secure weathertight room to meet the minimum requirements denoted in the Burn Building Prototype-1.
2. Temperature monitoring system and thermocouples shall meet or exceed system denoted in the electrical drawings for the Prototype-1 on Sheets E1.0 and E2.0.
3. Wall thermocouples to be installed at 30" or an intermediate wall height as designated by an instructor as long as the safety temperature is calibrated to that height, 90" (7'-6") AFF or greater, and as required by thermal insulation provider if required. Thermal lining engineer to determine behind insulation thermocouple placement to indicate temperature distribution in room during a burn behind insulation.
4. Provide manual or automated ventilation system for burn prop so that complete air exchange can be achieved within one minute. (As per section NFPA 1403.)
5. All junction boxes, including exterior ones, in and around the vicinity of the heat of burn and burn rooms, including ceiling conditions, fed from interior devices should be filled with ceramic fiber material to reduce heat transfer to copper connections.
6. Provide wire and cable suitable for the temperature conditions and location where installed.
7. Wiring devices to be heavy duty, hospital grade.
8. Wiring device covers to be waterproof, gasketed.

## **5. FUEL SOURCES**

### **A. GUIDELINES**

1. Burn building prop must be designed to provide for Class "A" and/or Class "B" fuels.

### **B. CLASS "A" FUEL SOURCE**

1. Class "A" combustible fuel shall be utilized in accordance with NFPA 1403.

### **C. CLASS "B" FUEL SOURCE**

1. The gas fueled fire training system shall utilize a Class "B" fuel source, such as, propane, or natural gas. The system shall have automated safety controls with instructor override and control of the fire, providing firefighters with comprehensive and safe simulated fire training.
2. The automated fire training system shall be designed and certified by a professional engineer licensed in the Commonwealth of Virginia.
3. The fire training system described in this document shall be installed in a burn building that is equipped with a ventilation system to remove excess heat, combustion by-products, and unburned gas from each training compartment within the building and ventilation system shall be designed to fully purge each training compartment at the rate of one (1) air change per minute as per NFPA 1403. The live fire training system shall control the operation and monitor the airflow of the ventilation system in the burn building. The ventilation system shall only be activated during the following conditions:
  - a) to fully purge the training compartments at power up.
  - b) to flush the burn building prior to training.
  - c) to fully purge the training compartments when excessive gas or temperature levels are detected during training.

4. The fire training system shall be designed based upon NFPA 1403. Consideration should be given in the initial design fuel source, hardware, and controls for possible expansion of the fire training system.
5. The fire training system manufacturer must have a minimum five (5) year history of experience with natural gas or propane gas-fueled live fire training system equipment.
6. The fire training system manufacturer shall submit written documentation that the live fire training equipment supplied has been certified and labeled by a Nationally Recognized Testing Laboratory (NRTL) to ensure that the equipment complies with the requirements of the following applicable standards. (An NRTL must meet the requirements of OSHA 29 CFR 1910.7 or current OSHA standard for NRTL requirements).
  - a) NFPA 54, the National Fuel Gas Code, or current NFPA Fuel Gas Code.
  - b) NFPA 58, the Standard for Storage and Handling of Liquefied Petroleum Gases, or current NFPA standard governing Storage and Handling of Liquefied Petroleum Gases.
  - c) NFPA 70, the National Electric Code, or current NFPA National Electric Code.
  - d) NFPA 86, the Standard for Ovens and Furnaces, Sixteenth Edition or current NFPA standard governing ovens and furnaces.
  - e) UL 508, the Standard for Industrial Control Equipment or current UL standard governing Industrial Control Equipment.
7. The fire training system shall have an Emergency Shutdown System that provides instructor wide access to shutdown or override system. System override controls such as push button shutdown (E-stop) shall be provided throughout the burn building prop to enable rapid shutdown of all gas control valves, and the facility's gas supply if an emergency condition occurs.
8. The fire training system shall have a Compartment Temperature Detection Sensor that monitors temperatures at 5'. If temperatures in the training compartment exceed 550° the ventilation system shall run. If temperatures at the 5' level exceed 700°, the system shall shutdown and the ventilation system shall run until temperatures are reduced.
9. The fire training system shall have a hard-wired emergency shutdown circuit throughout the facility to provide widespread access to shutdown (E-stop) push buttons. E-stop push buttons shall be located at the entrance(s) to each training compartment, on the scenario control assemblies, and on each control pendant. The effect of pushing any E-STOP button shall cause all burner control valves to close, facility gas supply to be secured and smoke production to stop. Ventilation fans will automatically run at maximum once the E-stop push button has been activated. The ventilation system will run continuously at maximum level until the E-stop has been manually reset and safe operating conditions exist.
10. The fire training system shall have a gas detection system which continually monitors unburned Class "B" fuel levels in the training compartments and any equipment rooms where Class "B" fuel lines are installed. A minimum of two (2) gas sensors shall be supplied per training compartment. If gas levels reach 10% LEL, the ventilation system shall run. If gas levels reach 25% LEL, the ventilation system shall run at maximum speed and all gas valves shall close. The ventilation system shall continually run until gas levels are reduced below 10% LEL.
11. The fire training system fuel control assembly shall connect to the Class "B" fuel supply line. The fuel control assembly shall consist of both high and low pressure switches. The line pressure shall be monitored for abnormal conditions and shall shut down the system if the line pressure is too high or too low. Should a high-pressure condition exist, the ventilation system shall start and an emergency shutdown shall occur.
12. A minimum of two (2) extinguishing agent sensors shall be located in each burn room with one (1) directly within the burn prop. The output of these sensors shall be utilized by the instructor to determine the effectiveness of agent application with regard to rate at which fire is extinguished.
13. All components in this system shall perform within the following minimum standards:
  - a. Control Room Equipment:
 

Temperature:	65 to 85 °F (Operating)
	20 to 125 °F (Storage)
Humidity:	0 to 95 % (Non-Condensing)



- b. Outdoor Equipment::
    - Temperature: 20 to 100 °F (Operating)
    - 20 to 125 °F (Storage)
    - Humidity: 0 to 100%
  - c. Compartment Equipment:
    - Temperature: 32 °F to max. (Operating)
    - 20 to 125 °F (Storage)
    - Humidity: 0 to 100%
  - d. Mechanical: All training compartment equipment shall withstand direct hose pressure of 100 PSI at 150 GPM from a distance of three (3) feet.
  - e. Total Training System: MTBF (Mean Time Between Failures) > 500 hours (Operating).
  - f. MTTR (Mean Time To Repair) < 30 minutes (when repairs are performed by qualified service personnel).
14. The fire training system manufacturer shall provide ten (10) copies of an operation and maintenance manual to the owner. The manual shall fully describe the delivered system and shall include sections on system operation, trouble shooting, and maintenance and associated diagrams, drawings, and a replaceable spare parts listing.
  15. The fire training system manufacturer shall conduct an operational readiness test with owner personnel in observance. The goal of the test shall be to show reliable operation of the system.
  16. The fire training system manufacturer shall provide a two (2) day operator's training course for up to ten (10) facility staff members. The course shall cover operation, calibration, and maintenance of the system.
  17. The fire training system manufacturer shall provide a warranty to cover all parts supplied with the system, calibration, and service for specified maintenance for a period of two (2) years from the date of system acceptance for training. If for any reason, other than misuse and abuse, a part supplied should fail, the fire training system supplier shall supply a replacement part to the owner. If a failure of the system cannot be corrected over the telephone using the supply of replacement parts, a fire training system supplier field technician shall be dispatched at no cost to the owner.